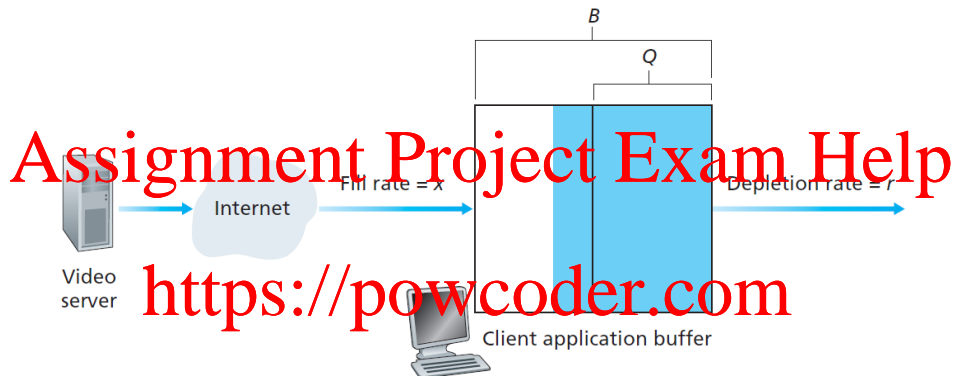


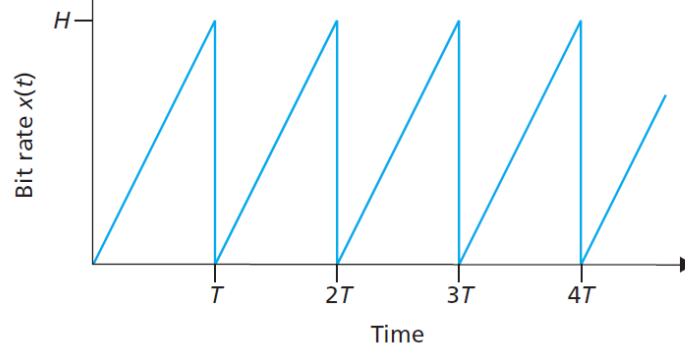
## COMP 5416 Week 7

1. Recall the simple model for HTTP streaming shown as follows.  $B$  denotes the size of the client's application buffer, and  $Q$  denotes the number of bits that must be buffered before the client application begins playback. Suppose the buffer size is infinite but the server sends bits at variable rate  $x(t)$ . Specifically, suppose  $x(t)$  has the following saw-tooth shape. The rate is initially zero at time  $t = 0$  and linearly climbs to  $H$  at time  $t = T$ . It then repeats this pattern again and again, as shown in the figure below.

- (1). What is the server's average send rate?
- (2). Now suppose  $Q > 0$ .  $Q < HT/2$ . Determine as a function of  $Q$ ,  $H$ , and  $T$  the time at which playback first begins.
- (3). Suppose  $H > 2r$  and  $Q = HT/2$ . Prove there will be no freezing after the initial playout delay.

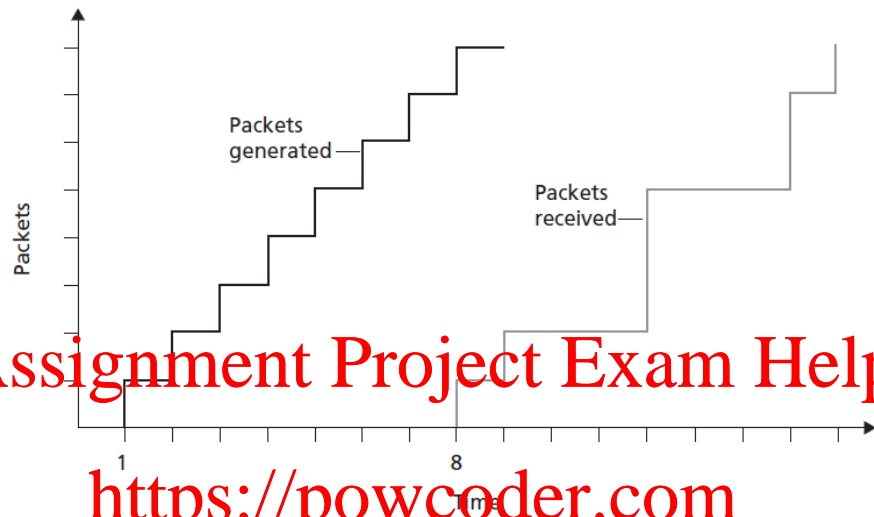


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2. Consider the figure below. A sender begins sending packetized audio periodically at  $t = 1$ . The first packet arrives at the receiver at  $t = 8$ .

- (1). What are the delays (from sender to receiver, ignoring any playout delays) of packets 2 through 8?
- (2). If audio playout begins as soon as the first packet arrives at the receiver at  $t = 8$ , which of the first eight packets sent will *not* arrive in time for playout?
- (3). If audio playout begins at  $t = 9$ , which of the first eight packets sent will not arrive in time for playout?
- (4). What is the minimum playout delay at the receiver that results in all of the first eight packets arriving in time for their playout?



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